STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
A. M. SHELTON, *Director*

DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief*

REPORT OF INVESTIGATIONS—NO. 15

PRELIMINARY REPORT ON THE FULLER'S EARTH DEPOSITS OF PULASKI COUNTY

BY
J. E. LAMAR

PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

URBANA, ILLINOIS
1928

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JEFFERSONS PRINTING & STATIONERY CO.
SPRINGFIELD, ILLINOIS
1928

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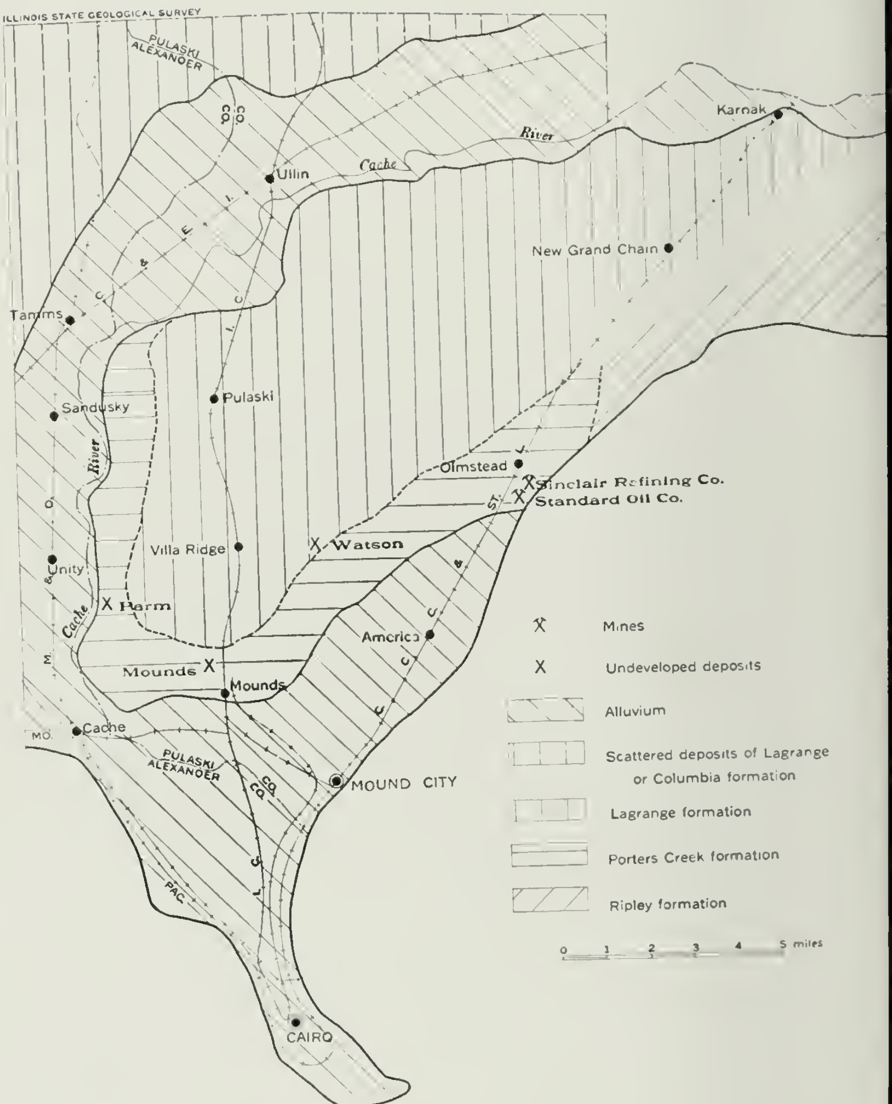

FIG. 1. Map of Pulaski County and the adjoining part of Alexander County.

PRELIMINARY REPORT ON THE FULLER'S EARTH DEPOSITS OF PULASKI COUNTY

By J. E. Lamar

INTRODUCTION

A series of unconsolidated sediments, but little known elsewhere in the State, outcrops in Alexander, Massac, and Pulaski counties of southern Illinois (fig. 1). To these sediments the geological names Cretaceous, Eocene, and Pliocene systems have been applied. The fuller's earth deposits form a part of the Eocene system.

The mining of fuller's earth in Illinois was begun by the Sinclair Refining Company at Olmstead in 1920, and later the Standard Oil Company of Indiana opened a mine near the same town. Since 1920 Illinois has increased its output of fuller's earth until, in 1926, only Georgia and Florida exceeded the State's production.

The fuller's earth deposit at Olmstead was generally supposed to be the only one in southern Illinois. During reconnaissance field studies of the economic mineral resources of Alexander, Pulaski, Union, and Massac counties in the summer of 1927 three additional deposits of clay, which are similar in appearance to the Olmstead deposit, were discovered in Pulaski County. Two of these deposits are located along railroads and the other is about one and a half miles from a railroad. Still other deposits probably exist which were not noted because of the reconnaissance character of the field work. Only the territory within half a mile of railroads was carefully studied.

The Cretaceous and Eocene beds of southern Illinois contain a variety of clays which possess in some degree the essential property of fuller's earth, that is, the ability to remove basic colors from oils. These clay deposits are not as thick or as extensive as the three deposits that are typically similar to the Olmstead deposits, and there is doubt as to the practicability of working such clays in competition with known fuller's earth deposits unless the clays are of exceptionally high quality. This report is therefore confined to those deposits of clay that are similar to the Illinois fuller's earth of known value.

ACKNOWLEDGMENTS

The writer wishes to acknowledge the willing and able assistance of Mr. C. E. Dutton in the field work, and of Mr. C. R. Clark in the laboratory work done in connection with this investigation; also the courtesies extended by Mr. Floyd Cannon, manager of the fuller's earth plant of the Sinclair Refining Company, and by Mr. J. F. Shanley, superintendent of the plant of the Standard Oil Company of Indiana. To Dr. M. M. Leighton, Chief of the Illinois State Geological Survey, the writer desires to express appreciation for valuable and constructive criticism of this report.

GEOLOGY

General Stratigraphy

The field work done in the three counties, though by no means of a detailed stratigraphic nature, was sufficient to indicate the succession of formations given in the following table. The sequence outlined checks well with the general stratigraphic succession given for Kentucky and Tennessee.[1] Usually it is difficult to determine exactly the contacts of any of the formations given below, yet they are recognizable as general units of sandy or clayey sediments. The correlations with the Tennessee and Kentucky sections are on the basis of lithology alone, inasmuch as fossils are extremely rare.

Generalized section of post-Paleozoic sediments of Alexander, Pulaski and Massac counties

Recent system
- Gravel, sand, silt and clay in the flood-plains of present streams, particularly Mississippi, Ohio, and Cache rivers.

Pleistocene system
- Loess formation
  - Loess, brown, noncalcareous, found principally some miles inland from broad alluvial flats.
  - Loess, gray, found on the margins of the highlands bordering the alluvial flats; noncalcareous; especially well developed south of Gale, in Alexander County, and in the vicinity of Cache in the same County.
- Columbia formation
  - Sand, with interbedded gravel and clay, or gravel with interbedded sand and clay; visible in cuts along Illinois Central Railroad about ½ mile south of Villa Ridge in Pulaski County, and in the gravel pit of the Elco Gravel Company at Elco, Alexander County.

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1 Glenn, L. C., Underground waters of Tennessee and Kentucky west of Tennessee River and of an adjacent area in Illinois: U. S. Geological Survey, Water-Supply and Irrigation Paper, No. 164, pp. 21-51, 1906.

Pliocene system

Colluvium

Clay, red and brown, containing sand, gravel or angular sandstone fragments; best developed near Round Knob, Massac County.

"Lafayette" formation

Chert gravel, polished, brown, locally underlain by a very coarse red sand; red sand and gravel well developed at Fayville, Alexander County; gravel well developed south of Unity, and at Mounds, Pulaski County, and at Metropolis and Round Knob, Massac County.

Eocene system

Lagrange formation

Clays, dominantly white, pinkish, greenish or gray, with interbedded sands, and thin gravel strata locally; also thin lignite or lignitic beds. The clays worked at Kaolin, Union County, are probably part of this formation, also the clay, sand and thin gravels exposed along Mississippi River between Fayville and Thebes in Alexander County, and the clays and sands along the Cleveland, Cincinnati, Chicago and St. Louis Railway northeast of Grand Chain in Pulaski County.

Porters Creek formation

Clay, gray-black or blue-gray, dominantly buff-gray, locally sandy in the basal portion. The upper part of this formation is the source of the fuller's earth at Olmstead. It also outcrops a few miles south of Unity, at Mounds, and about 2 miles east of Villa Ridge, all in Pulaski County.

Cretaceous system

Ripley formation

Sands, fine- to medium-grained, micaceous, locally yellow, with thin interbedded clays. The basal portion contains sandy clays. The sandy phase of this formation is well exposed at Dam 53 northeast of Olmstead, at Post Creek cut-off, and northeast of Olmstead in Pulaski County; the sandy clays at Round Knob and Choat in Massac County.

The Porters Creek Formation

The Porters Creek clay is persistent both lithologically and stratigraphically. It does not become plastic when wet and consequently does not slump and slide as do the majority of the Cretaceous-Tertiary clays. In a number of logs of wells drilled in Alexander and Pulaski counties the Porters Creek is described as gray or blue shale or marl, and from the description and its thickness is easily recognized. Neither the upper or lower contacts of the Porters Creek were observed but it is thought to be unconformable with the Ripley below and conformable with the Lagrange above. The basal unconformity results in considerable irregularity in the base of the formation and therefore great variation in thickness.

LITHOLOGIC CHARACTER

The Porters Creek, as seen in outcrop, is a massive gray-black, buff, or gray, micaceous, clay. It is very tough when wet and develops a slippery surface but does not become plastic except after thorough kneading. Because of this property it stands in unusually steep faces where topographic conditions are favorable. The formation consists of two distinct units, an upper 15 to 40 feet of gray or buff, very slightly sandy clay, and a lower 40 to 65 feet of blue-gray or gray-black, commonly sandy clay. The upper gray portion is that mined and sold as fuller's earth.

An outstanding feature of the Porters Creek, observed in outcrops, is its concretionary or nodular structure which is especially well shown in the weathered exposures of the upper gray portion of the formation. As a result of this structure the talus developed from the gray Porters Creek is composed typically of conchoidal or shell-shaped fragments. Bedding occurs but on the whole is not well developed except as a gross feature. Vertical or nearly vertical jointing is pronounced in some areas and is usually accompanied by iron stains along the joint planes.

THICKNESS

Where the Porters Creek is well developed, as at Cairo, its thickness varies from 112 to about 130 feet. The formation apparently thins to the north and northeast for at Mound City it is 100 feet thick, as recorded in a water well, and at Olmstead 80 feet and less. At Mounds 65 feet of Porters Creek was encountered below 55 feet of alluvial gravels, but this is not thought to represent the entire thickness of the formation in that area.

The sand contained in the upper 30 feet of the Porters Creek is principally quartz with very small amounts of zircon and tourmaline. The lower portion of the formation is the more sandy part, and in the extreme basal portion the formation contains thin interbedded sand strata.

AREAL DISTRIBUTION

Extensive natural exposures of the Porters Creek are rare because the overlying Lagrange formation contains many very plastic clays and consequently slumps badly. Beginning at Olmstead, where the upper part of the Porters Creek is mined as fuller's earth, the formation rises sharply, and apparently thins, to the east. At Caledonia Landing, a very short distance northeast of the fuller's earth plants, the underlying McNairy sands of the Ripley formation appear in the base of the Ohio River bluff, and still farther northeast they form the major portion of the bluff. The base of the Porters Creek is very irregular so that the thin marginal portion of the formation has a "pockety" distribution. It is thought to be thin northeast from Olmstead in the direction of Karnak. Clays and sands, apparently of Lagrange age, which are exposed in the railroad cut about a mile northeast of Grand Chain, suggest that the Porters Creek may be present at a shallow depth in this vicinity if it has not pinched out.

Southwest from Olmstead the Porters Creek is thought to extend almost due southwest to Mounds, with small outcrops about two and a half miles east of Villa Ridge and just north of Mounds. From Mounds the outcrop probably trends northward along the east side of Cache River and may be seen about one and a half miles south of Unity. From this point north the formation is visible for but a short distance and either disappears under the alluvium of Cache Creek or pinches out.

The accompanying well logs show that the depth to the Porters Creek is 180 feet at Mound City and 375 feet at Cairo. Between the cities of Mounds and Cairo, a distance of about eight miles, the formation dips about 380 feet, or 48 feet per mile. From Mound City to Cairo the dip is about 25 feet per mile, indicating that the dip of the beds is principally south or southwest.

Log of Ice Plant well at Mound City

	Thickness *Feet*	Depth *Feet*
6. Clay, surface	20	20
5. Gravel and sand	160	180
4. Shale, blue	100	280
3. Sand, dark	25	305
2. Gravel	300	605
1. Limestone	45	650

Bed 6 of the above log is probably river alluvium. Bed 5 is thought to be river gravel, "Lafayette" gravel, and Lagrange sand. The blue shale, bed 4, is the Porters Creek and bed 3 the Ripley sand. The gravel, bed 2, is probably fractured Clear Creek chert similar to that outcropping near Olive Branch. Bed 1 is probably the Backbone limestone. Both beds 1 and 2 are of Devonian age, in contrast with the overlying beds which are of Cretaceous, and later age. (See geologic column, pp. 8-9.)

Log of well at Cairo Electric Light and Power Company, Cairo

	Thickness Feet	Depth Feet
12. Soil	4.5	4.5
11. Clay, sandy, blue	50.5	55
10. Sand and gravel	60	115
9. Sand, with "kaolin" partings	15	130
8. "Kaolin"	4	134
7. Sand, with a thin layer of "kaolin" and traces of lignite	240	374
6. Shale, or marl, slate colored	124	498
5. Sand, very soft	20	518
4. Shale and lignite partings	5	523
3. Chert or chert gravel	177	700
2. Chert pebbles	5	705
1. Sandstone, reddish, calcareous	335	1,040

The above log is correlated as follows: beds 12 and 11, probably river alluvium; bed 10, probably river-deposited sand and some "Lafayette" gravel; beds 9, 8, and 7, Lagrange formation; bed 6, Porters Creek clay; beds 5 and 4, Ripley formation; beds 3, 2, and 1, Clear Creek chert. The lower part of bed 1 may be a siliceous phase of the Backbone limestone, though the red color is suggestive more of the Clear Creek than the Backbone formation. Beds 1, 2, and 3 are Devonian in age, the others of Cretaceous, and later age. (See geologic column, pp. 8-9.)

FULLER'S EARTH

Physical Properties

The term fuller's earth was originally applied to clay used for fulling woolen cloth. As used at present, however, it describes a highly siliceous clay, usually indurated, which has the property of absorbing certain basic colors from oils. Fuller's earth is generally not plastic until ground, and when thoroughly dry will float in water because of its high porosity. Because of this property it appears to be of very light weight though its true specific gravity is close to that of other clays. It is commonly brittle, and buff, gray, or dark gray in color. The light-colored earths are generally considered of higher quality than the darker earths.

The exact manner in which fuller's earth removes basic colors from oils is not precisely known, but it is thought to be "a combination of adsorption and mechanical filtration accompanied by some chemical disintegration due to selective adsorption. The active constituents of the earth are probably hydrous silica and hydrous aluminum silicates. The porous nature of the earth, due to the fact that it is built up of grains approaching colloidal size, offers large active surface."[2]

Value of Chemical Analyses

In general, a chemical analysis of a sample of fuller's earth is of little value to indicate its absorptive power except as the analysis shows the amount of hydrous silica or silicates present. It also indicates, in a general way, what impurities are present, but these may often be more easily determined by a study of the silt and sand residues separated by mechanical analysis.

Commercial Value

The commercial value of an earth depends on its bleaching power. Some earths are capable of bleaching both vegetable and mineral oils, but most earths are suited best to filtering one or the other type of oil.

Uses

As stated, the most important use of fuller's earth is that of clarifying or filtering mineral and vegetable oils, fats, and greases. It is also "said to be used in the manufacture of pigments for printing wall paper, in detecting certain coloring matters in some food products, as a substitute for talcum powder, and in medicine as a poultice and as an antidote for alkaloid poisons."[3]

THE FULLER'S EARTH INDUSTRY OF PULASKI COUNTY

The fuller's earth industry of Illinois is centered at Olmstead in Pulaski County (figs. 1 and 4) where the Sinclair Refining Company and the Standard Oil Company of Indiana operate mines and mills (figs. 2, 3, 5, and 6). Both mines are located in the same deposit.

The Deposit

The general ground-plan of the fuller's earth operations and the vicinity is shown in figure 4. From the mines of the Sinclair Refining Company the deposit dips to the southwest and in the mine of the Standard Oil Company is occurs at a somewhat lower elevation. Further southwest the formation continues to lower until it merges into the flood-plain and low bluffs bordering Ohio River. Northeast of the Sin-

[2] Maynard, T. P., and Mallory, L. C., Commercial preparation and uses of fuller's earth: Chem. and Met. Eng., vol. 26, No. 23, pp. 1074-1076, June 7, 1922.

[3] Middleton, J., Fuller's earth in 1926: U. S. Bur. Mines, Mineral Resources 1926, Pt. II, p. 10, July 18, 1927.

Fig. 2. The mill and incline to the mine of the Standard Oil Company of Indiana, Olmstead, Illinois

Fig. 3. The mill of the Standard Oil Company of Indiana, Olmstead, Illinois

clair Refining Company's mine the deposit rises sharply to the north or northeast. About a quarter of a mile southwest of Caledonia Landing the Porters Creek formation forms the river bluff just above the level of the flood-plain. At the landing 30 feet of Ripley sands and silts is

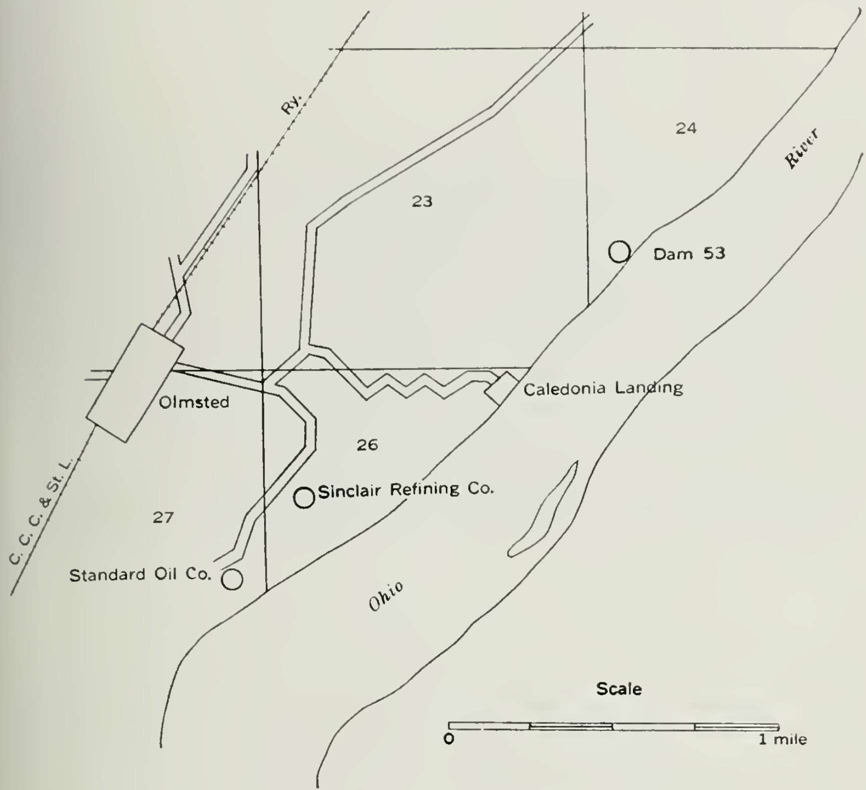

FIG. 4. Map of the Olmstead area

exposed below the Porters Creek. In sec. 13 the Porters Creek formation has thinned to such an extent that only a feather edge remains, probably the thin beds of the basal portion which are sandy and interbedded with sand and clay.

Conspicuous settling and creep has occurred along the margin of the Ohio River bluff, particularly where the underlying Ripley sands and silts form the lower part of the bluff. In the mines, however, where the formation is best exposed, it shows but little slumping or creeping.

The top of the Porters Creek is fairly level, but is irregular enough to cause a variation of from 15 to 40 feet in the thickness of the upper white, or light buff zone, of the formation.

The best fuller's earth is found in the upper buff or light gray portion of the Porters Creek formation. The lower portion, which is dark gray or blue-gray, is commonly inferior in quality to the gray earth, due probably to its higher sand content and a difference in the quantity and character of the colloidal material present. The gray color of the upper earth is apparently due to weathering, for the greatest thicknesses appear to occur in those tracts that are highest with reference to the major drainage lines of the region.

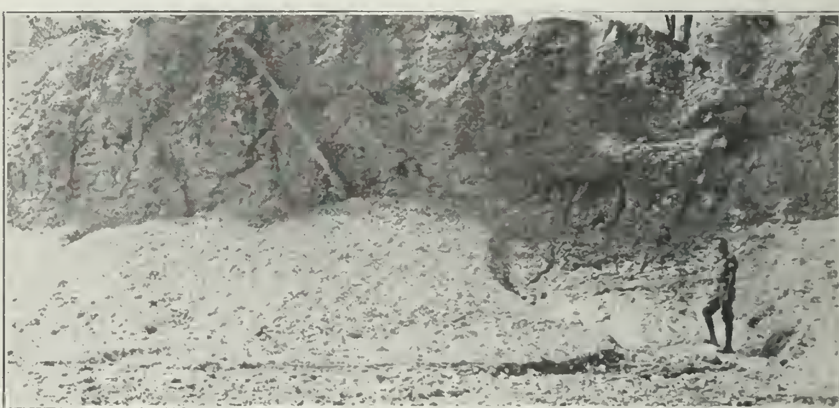

Fig. 5. Fuller's earth in the mine of the Sinclair Refining Company, Olmstead, Illinois

The upper gray fuller's earth exhibits gross features of bedding but is nodular and fractured by vertical or nearly vertical joints (fig. 5). Because of the nodular character of the deposit the material appears to have a conchoidal fracture. Parts of the deposits are speckled with brown spots of iron stain and similar staining is found along many of the joint planes.

The Overburden

The overburden at both the Sinclair Refining Company's mine (fig. 6) and the Standard Oil Company's mine consists of 3 to 5 feet of clayey, brown chert gravel, overlain by 10 to 25 feet of loess. As the deposits are worked back into the hills it is probable that clays and sands of the overlying Lagrange formation will be encountered.

Methods of Mining and Milling

Both mines are operated as open pits; stripping and loading is by steam shovel (fig. 6). The mine cars are pulled up the incline to the plant by cable (fig. 2) and dumped into a bin which feeds by a chain, or plate feed, into a wet roll crusher. In the Sinclair Refining Company's mill the earth from the crusher is elevated to a bin and spouted to rotary driers which discharge to bucket elevators. These convey the earth to bins which discharge to pulverizers. From the pulverizers the earth is transferred by an air injector system to the dust collectors, from which

Fig. 6. The mine of the Sinclair Refining Company, showing the method of loading, the overburden, and general character of the deposit. Olmstead, Illinois.

it goes to Ro-tex screens. From the screens the earth goes to bins which discharge to the sacking machines.

In the Standard Oil Company's mill the earth from the crusher is elevated and spouted directly to rotary driers. These discharge to bucket elevators, which convey the earth to bins from which it is distributed to the pulverizers. Bucket elevators transfer the earth from the pulverizers to Ro-tex screens and flour mill sifters which discharge to the sacking machines.

Grades of Fuller's Earth Produced

The pulverized earth is produced in four standard grades, namely:

Through 16 mesh, retained on 30 mesh
Through 30 mesh, retained on 60 mesh
Through 60 mesh, retained on 90 mesh
Through 100 mesh.

It is sold in sacks holding 100 to 200 pounds and is used for clarifying mineral, vegetable, and animal oils. The capacity of the plant of the Sinclair Refining Company is 200 tons in 24 hours, and of the plant of the Standard Oil Company 120 tons in 24 hours.

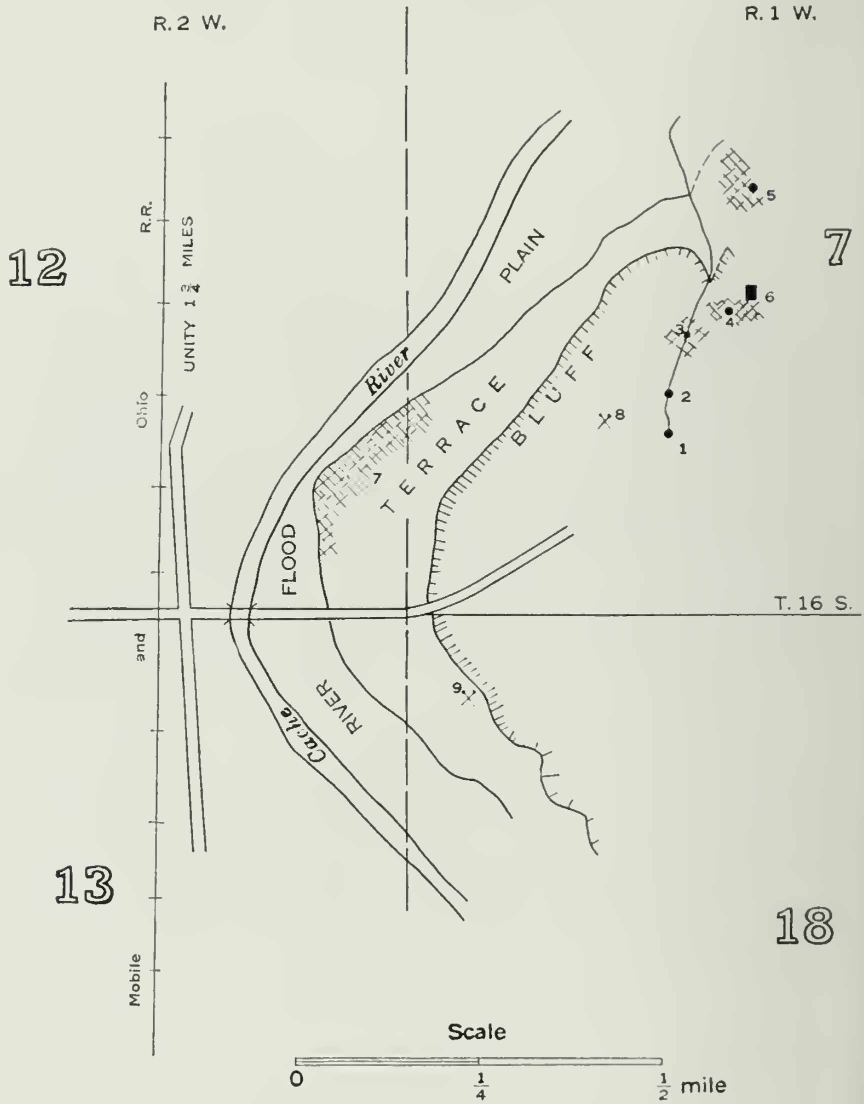

Fig. 7. Sketch map of the Parm deposit

DESCRIPTION OF LOCALITIES

1. Lafayette gravel
2. Lagrange sand
3. Gray-black fuller's earth
4. Gray fuller's earth
5. Light gray fuller's earth
6. Parm house
7. Light gray fuller's earth
8. Gravel pit "Lafayette" gravel
9. Gravel pit, "Lafayette" gravel

Samples

The Olmstead fuller's earth is known to be of high quality and samples were therefore taken from the mine of the Sinclair Refining Company, as indicated below, to serve as a basis for comparison with other fuller's earths of southern Illinois.

Sample 63—west quarry face.
Sample 64—lower 25 feet of dark gray earth. Not being quarried.
Sample 65—south quarry face.
Sample 66—prepared earth from mill.

POTENTIAL SOURCES OF FULLER'S EARTH FROM THE PORTERS CREEK CLAY

The Parm Deposit

INTRODUCTION

Exposures of the Porters Creek formation on the Parm farm, and therefore referred to as the "Parm deposit," occur in the SW. ¼ sec. 7, T. 16 S., R. 1 W., and in the SE. corner sec. 12, T. 16 S., R. 2 W. (fig. 1). As shown in figure 7 the deposit lies about one and three quarters miles south of Unity on the east side of Cache River.

DESCRIPTION OF REGION AND EXPOSURES

In this region the Cache flows in a channel along the east margin of its flood-plain. It is bordered on the east side by bluffs, in some places steep, elsewhere moderately gentle. In the specific area of the Parm deposit the flood-plain on the east side of the river is comparatively narrow (fig. 7) and is locally succeeded by a low terrace. At locality 7, figure 7, this terrace is composed of gray fuller's earth, which outcrops along small valleys intersecting the terrace and forms talus on the frontal slopes of the terrace itself. At locality 5, where the terrace and bluff appear to have combined, a similar gray fuller's earth is visible in the small washes.

East of the terrace is the bluff of the east valley-slope. This is for the most part covered by vegetation, but some of the small valleys, as at locality 1, and gravel pits, 8 and 9, expose brown chert gravels and associated red or yellow sands of the "Lafayette" formation. Other valleys contain outcrops of white or gray sands thought to be part of the Lagrange formation. The following section is exposed at locality 2:

	Thickness *Feet*
"Lafayette formation"	
Gravel, composed of white and brown chert	1
Lagrange formation	
Sand, white, clayey, fine- to medium-grained	4
Sand, yellow, clayey, fine- to medium-grained	5
Covered	

Some of the valleys cutting back into the bluff also expose fuller's earth, and at 3 about 7 feet of gray-black Porters Creek clay outcrops in the west bank of a small valley.

LITHOLOGIC CHARACTER OF THE PORTERS CREEK

From an examination of the scattered and small outcrops of the Porters Creek formation in the Parm deposit it appears that the formation is similar to that at Olmstead, and consists of an upper light gray or buff member underlain by a gray-black basal portion. The upper member is probably not over 30 feet thick in the Parm deposit and will doubtless be found to vary considerably in thickness, depending on whether it has been subject to much or little river erosion. The upper gray portion of the formation has the same general physical characteristics as that mined at Olmstead, particularly the nodular character and the property of weathering into thick conchoidal or shell-like fragments. The lower gray-black member is also similar to the lower member at Olmstead. No data are available to indicate the thickness of this part of the formation.

OVERBURDEN

As indicated, the overburden on the Porters Creek in the bluff area consists of sands, gravel, and loess. The thickness varies from a few feet at the riverward margin of the bluff to a maximum thickness estimated at between 40 and 60 feet in the higher parts of the bluff and upland. In the terrace tract the overburden is thin, probably not more than three feet in most places, and in many places less than a foot. The exposed overburden on the terrace consisted of river silt and soil, but near the base of the bluff it is probable that some sand and gravel, washed on to the terrace from the bluff, will also be found.

EXTENT OF DEPOSIT

The approximate extent of the Parm deposit, as known from outcrops of the Porters Creek formation, is shown in figure 7. The deposit probably extends further northeast than shown and also somewhat further southeast. The Porters Creek, however, disappears in the bluff east of Unity about one and three quarters miles farther north, either because it pinches out or dips below the level of the flood-plain of Cache River. To the southeast, outcrops, if present, were concealed by a mass of vegetation and by slope wash at the time the area was visited. It seems probable, however, that the formation extends in this direction, but for what distance it remains above the level of the flood-plain of the river is not known.

The area west of Cache River is all a part of the river flood-plain and consequently, though the lower part of the Porters Creek probably underlies the alluvial filling of the flood-plain tract, there are no data to indicate its depth or character.

SAMPLES

It is impossible to determine accurately the character of the Parm deposit without digging test-pits to obtain samples from the entire vertical thickness of the deposit. However, three samples were taken to indicate what certain parts of the deposit would test, and to show, if possible, whether further sampling, as outlined below, would be warranted. Sample 35 was taken from locality 3; sample 35a from locality 5; and sample 36 from locality 4. The results of the tests made on these samples (p. 29) indicate that the dark gray earth from locality 3 and the gray earth from locality 5 are about the same in regard to specific volume. Sample 35 has the higher apparent acidity. In these properties the samples compare favorably with the earth from Olmstead. Sample 36 has an apparent acidity comparable with the other samples but has a somewhat higher specific volume.

Samples of gray fuller's earth from this deposit were tested at the Mississippi Agricultural and Mechanical College and were reported to be an excellent grade of earth for bleaching vegetable oils, leaving them water white, but having practically no effect on mineral oils.[4]

PROSPECTING AND TESTING

INTRODUCTION

Though it appears from the foregoing discussion that there is probably a workable deposit of fuller's earth in the area discussed, it is highly recommended that thorough prospecting and testing of the deposit be undertaken before a mine or mill is put into operation. This prospecting should take into account the thickness, character and distribution of the

[4] Personal communication, A. M. Davis, International Silica Company, Cairo, Illinois, Oct. 18, 1927.

gray fuller's earth, and the overburden. Should the gray-black clay beneath the gray earth be found to be valuable, the data secured concerning the gray earth and overburden will furnish information on the gray-black clay also. The data obtained from the prospecting will serve as a basis for directing the exploitation of the deposit, and for estimating resources.

TEST DRILLING

In order to thoroughly test the deposit it is suggested that test-holes be drilled on the terrace tract and on the portion of the bluff that borders the terrace. The holes should be drilled about 500 feet apart and equidistant. All tests should penetrate all of the gray earth and at least one should be carried through the gray-black clay to ascertain its character. In test-drilling it is desirable that a practically continuous core of the formations penetrated be obtained, in order that a complete description of the deposit may be made and that representative samples may be available for laboratory tests. A portable diamond-drill, capable of taking 3-inch cores to a depth of about 100 feet, would serve very well for testing this deposit. If the laboratory tests on the cores indicate that the fuller's earth is of good quality, and the size, character and shape of the deposit are favorable for commercial exploitation, it would doubtless be advisable to dig a pit in a representative part of the deposit in order to obtain a sample of such size that it could be tested in commercial filters.

TOPOGRAPHIC MAPS

Such small scale topographic maps as are available[5] will be of value in directing preliminary development work. If, however, tests on the samples prove the deposit of commercial value, it is highly desirable that a topographic map be made which will indicate in detail the surficial features of the deposit. This map should be made on a conveniently large scale, for instance, 1 inch to 500 feet, and for the deposit under consideration should have a contour interval of 5 feet.

MINING

It is impossible, from the limited data available concerning the details of the Parm deposit, to specify just where and how mining should be undertaken. Attention may be called, however, to some factors which should be considered in outlining open-pit mining operations. The mine

[5] Topographic maps of the northern third of Pulaski County—the Jonesboro and Dongola quadrangles—are now available. The quadrangles covering the remainder of the county, the Thebes and Mounds quadrangles, are in the course of preparation and may be secured when printed by addressing the Chief, Illinois State Geological Survey, Urbana, Illinois.

will probably be worked so that its bottom will be at or below the level of the flood-plain of Cache River. Inasmuch as this flood-plain is subject to overflow at times of high water, precautions should be taken to prevent flooding of the mine at such times. It is probable that the stripping and waste material involved in opening the deposit will be sufficient to construct a levee along the west margin of the deposit. The precise placing of the levee can be best determined from the topographic map. This levee can be repaired or added to with overburden incident to stripping as the deposit is worked.

The surface water from the bluff tract is normally cared for by small gulleys running from the bluffs, through the terrace, to the Cache. The disposal of this run-off demands serious consideration. Possibly a ditch at the foot of the bluff, so located as to intercept the water before it gets on to the terrace, and to discharge at some convenient place into Cache River, would be effective.

From the data at hand there seems to be no reason why steam-shovel stripping and loading as practised at Olmstead should not be feasible here. The location of the mill for drying and grinding the earth will depend on information obtained during the exploration work. It would seem desirable, however, to locate the mill along the Mobile and Ohio Railroad on the west side of Cache River, and bring the raw fuller's earth across the river to the plant.

The Mounds Deposit

INTRODUCTION

The deposit near Mounds, described as the Mounds deposit, is located near the center of the E. ½ E. ½ sec. 16, T. 16 S., R. 1 W. (figs. 1 and 8). The extent of this deposit is not known but its favorable location topographically and with reference to transportation make it worthy of testing.

DESCRIPTION OF REGION AND EXPOSURES

The exposure of Porters Creek clay, thought to be fuller's earth, occurs in a small gulley in the bottom of one of several gravel pits operated by Mr. C. F. Wheeler. These gravel pits are located in a south-facing, comparatively gentle bluff that extends to the east and west of the gravel pits. A composite section of the formations exposed in the gravel pits follows:

	Thickness *Feet*
Pleistocene system	
Loess formation	
Loess, dark gray	5 to 20
Loess, brown	trace to 10
Pliocene system	
Lafayette formation	
Gravel, chert, brown, and interbedded sand. The sand is rounded, white, yellow and red. It occurs in lenticular deposits and locally contains clay lenses	5 to 15
Eocene system	
Lagrange formation	
Clay, buff and pink, silty	3 to 5
Porters Creek formation	
Clay, gray-black	3
Clay, buff, gray	3
Covered	

Extending south from the foot of the bluff is a terrace which passes into the general level of the valley flat without any sharp line of demarcation. The surface of the terrace is slightly rolling and is from 10 to 15 feet above the level of the valley flat. A spring zone just south of the road near the east end of the gravel excavations probably indicates the top of the Porters Creek at that place.

LITHOLOGIC CHARACTER AND THICKNESS

Because of the limited number of outcrops of the Porters Creek it is impossible to state the character of the deposit as a whole. However the light and dark gray clay exposed is, to all outward appearances, similar in physical properties to the gray and dark gray fuller's earth at Olmstead and in the Parm deposit. A water well drilled on the terrace adjacent to the bluff where the gravel pits occur is reported to have penetrated 40 feet of gray clay, suggesting that at least 40 feet of the Porters Creek formation is present. What part of this is valuable as fuller's earth cannot be told without testing.

OVERBURDEN

The overburden on the terrace, which would doubtless be the site of the mine were the deposit worked, consists principally of silt and, near the bluff, of sand and some gravel wash from the bluff. In places the overburden on the terrace is probably less than 3 feet thick; elsewhere it may average 5 or 6 feet.

EXTENT OF THE DEPOSIT

The deposit probably extends in the terrace east and west of the gravel pit for a considerable distance. However, there are no data to indicate its exact extent.

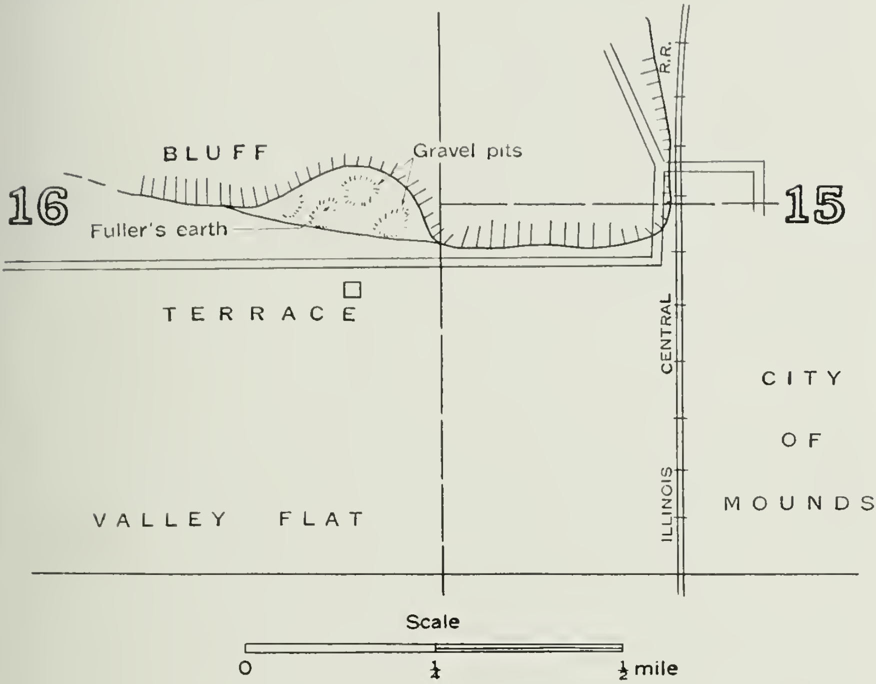

Fig. 8. Sketch map of the Mounds deposit

SAMPLES

In order to test that part of the deposit which was exposed two samples were taken, No. 87 from the basal three feet of light gray fuller's earth and No. 88 from the upper dark bed. Both samples have a higher specific volume than the Olmstead fuller's earth, but the apparent acidity is slightly lower (p. 29). These tests may indicate that the earth would absorb less oil than the Olmstead earth but would be somewhat less efficient as a bleaching agent. It should be noted, however, that only the upper six feet of the deposit was tested, and that below this the deposit may be similar in quality to that at Olmstead.

PROSPECTING AND TESTING

It is recommended that a procedure similar to that outlined for the Parm deposit, with reference to test-drilling and topographic maps, be followed for the Mounds deposit.

MINING

The details of mining can best be worked out after the test-drilling. The plant could probably be located on the valley flat, either on one of the switch yard tracks of the Illinois Central Railroad or on a short spur.

The Watson Deposit

LOCATION, DESCRIPTION OF REGION AND DEPOSIT

This deposit is located on the Watson farm in the SE. ¼ sec. 36, T. 15 S., R. 1 W. (fig. 1). The exposure of Porters Creek, thought to be fuller's earth, occurs in a small valley approximately at the center of the W. ½ SE. ¼ of the section. This valley is one of a number which dissect the region into a series of long sweeping hills, and is part of a drainage system which extends southeast from sec. 36.

LITHOLOGIC CHARACTER AND THICKNESS

The exposure of Porters Creek consists of about 3 feet of buff-gray clay, possessing the general physical properties of the upper buff or gray earth at Olmstead and the Parm deposit. The outcrop is covered above and below by loess. However, at the Watson residence about a half mile east, a water well penetrated the following formations:

Log of Watson well

	Thickness *Feet*
Soil	16
Gravel	1½
Soapstone, gray	35+
Bottom of well	

The soapstone bed mentioned is doubtless the Porters Creek.

OVERBURDEN

The above well log gives an idea of the character and thickness of the overburden at one place. However, because of the irregularity of the topography, it is impossible to give similar figures for the deposit as a whole. It is probably less than three feet in places, and back in the hills away from the outcrop it may be well over thirty feet. Part of the overburden will be found to be loess; the rest probably gravel, sand, and clay of the Lafayette and Lagrange formations.

EXTENT OF THE DEPOSIT

The distance between the outcrop noted and the Watson well is about a half mile, and therefore the deposit can be assumed to have at least that extent.

SAMPLE

Sample No. 122 was taken from the 3-foot outcrop of Porters Creek. The specific volume of the sample is but slightly less than that of the Olmstead earth and its absorption of oil may, therefore, be about the same. Its apparent acidity is slightly greater than some of the Olmstead samples.

PROSPECTING AND TESTING

It is recommended that the same general plan of prospecting and testing outlined for the Parm deposit be undertaken for this deposit, with the additional suggestion that test-holes be located so as to prove that part of the deposit where the overburden is less than 25 feet thick. The location of successive tests will be governed by data from preceding tests.

MINING

The procedure to be followed in mining cannot be outlined without data on the character of the deposit. Inasmuch as the deposit is located about one and a half miles west of the Illinois Central Railroad at Villa Ridge and the intervening country is hilly, it might be desirable to haul the fuller's earth by truck or wagon to a mill located along the railroad at Villa Ridge. A gravel road to Villa Ridge lies along the north line of section 2 about a quarter of a mile north of the outcrop described.

SAMPLING AND TESTING

Sampling

In sampling a fuller's earth deposit all weathered material was removed from an area about two feet wide and the height of the exposure. From all parts of this area equal amounts of clay were taken to make up a 30-pound sample. The sample was placed in a cement sack and labeled with the location of the deposit and a sample number for reference.

Testing

Inasmuch as it was impossible to obtain even approximately representative samples from the undeveloped deposits because they are of such limited vertical extent, no bleaching tests were made. Two simple tests were made, however, for comparison with samples of the earth being mined at Olmstead and elsewhere in the United States. The results obtained are not absolute and should be considered as merely suggestive.

TEST FOR SPECIFIC VOLUME

The specific volume of a clay is the weight of a unit volume of finely ground clay, compacted as much as possible, expressed as specific gravity, or pounds per cubic foot. The specific volume was determined for two sizes of earth; that passing a 20-mesh and retained on a 40-mesh screen, and that passing a 60-mesh and retained on a 100-mesh screen. Each sample was thoroughly dried and then placed in a small Erlenmeyer flask of known volume and weight. The flask was tapped on a table until it would hold no more earth. It was then weighed and the weight of the earth determined by subtracting the weight of the flask from the total weight.

In regard to the value of specific volume determinations Parsons says, "The volume occupied by a definite weight of fuller's earth is of importance as affecting the number of times a filter press must be opened for a given quantity of earth and also in determining the size of measure to use in adding the earth to the oil." Shearer, discussing specific volume measurements made as outlined above states, "It was found that, allowing for errors in the rather rough methods used, the absorption of oil by an earth varies inversely as the density."[7]

TEST FOR APPARENT ACIDITY

This test was made by titrating two grams of fuller's earth in suspension in 100 cc. of water with N/10 sodium hydroxide solution, using phenolphthalein as an indicator. The result is expressed as the amount of sodium hydroxide necessary to produce a "neutral" condition in a suspension of 100 grams of clay in water. This test does not indicate that the fuller's earth actually has any acid properties, but merely indicates the power of the earth to absorb bases. Concerning the importance of this test Parsons says, "Although it should be noted that the bleaching power is not proportional to the degree of 'acidity' it is, however, a striking fact that those earths which show by this test the highest absorptive power for bases, are also those which have the strongest bleaching power."[8]

TESTS ON CLAYS FROM ALEXANDER, MASSAC AND PULASKI COUNTIES

In table 1, which follows, are given the results of tests made on southern Illinois clays and fuller's earths. Some of these have already been described in the text; a description of the others follows the tables.

6 Parsons, C. L., Fuller's earth: U. S. Bur. Mines, Bull. 71, p. 30, 1913.
7 Shearer, H. K., The bauxite and fuller's earth of the coastal plain of Georgia: Geol. Survey of Georgia Bull. 31, p. 157, 1917.
8 Parsons, C. L. Op. cit., p. 32.

TABLE 1.—*Tests on clays from Alexander, Massac, and Pulaski counties*

Sample Number	Locality	Described in text on page	Specific volume				Apparent acidity cc. N/10 NaOH per 100 grams of clay
			Specific gravity		Lbs. per cu. ft.		
			−20+40	−60+100	−20+40	−60+100	
24	Elco	30	1.15	1.05	71.8	65.5	4.0
35	Unity	21	.65	.62	40.6	38.7	130.0
35a	Unity	21	.64	.62	39.9	38.7	92.0
36	Unity	21	.96	.88	59.9	54.9	94.0
38	Fayville	30	.99	1.03	61.8	64.3	34.0
39	Fayville	30	1.06	.98	66.1	61.2	100.0
63	Olmstead	19	.64	.60	39.9	37.4	78.0
64	Olmstead	19	.63	.59	39.3	36.8	70.0
65	Olmstead	19	.64	.59	39.9	36.8	46.0
66	Olmstead	19	.71	.67	44.3	41.8	70.0
87	Mounds	25	.83	.75	51.8	46.8	54.0
88	Mounds	25	.81	.74	50.5	46.2	46.0
92	Round Knob	31	1.04	.96	64.9	59.9	20.0
122	Villa Ridge	27	.62	.56	38.7	34.9	78.0

TESTS ON FULLER'S EARTHS NOT IN SOUTHERN ILLINOIS

Table 2 gives the results of tests, similar to those in table 1, which have been made on fuller's earths foreign to Illinois. It is of interest to note that analyses of Illinois earths compare quite favorably with the analyses of earths shown in table 2, except for the high apparent acidity of the Georgia earth, and the high specific volume of the English and Arkansas earths.

TABLE 2.—*Tests on fuller's earths other than those found in Illinois* [a]

Locality	Specific volume Lbs. per cu. ft.	Apparent acidity cc. N/10 NaOH per 100 grams of fuller's earth
England (IXL brand)	75	60
Georgia (Pikes Peak brand)	40	230
Ellenton, Fla.	36	30
Klondike, Ark.	75	65
Summerville, Tex.	61	120
Vacaville, Cal.	51	0.0

[a] Parsons, C. L., Fuller's earth: U. S. Bur. Mines, Bull. 71, p. 31-32, 1913.

DESCRIPTION OF SAMPLES TESTED AND NOT PREVIOUSLY MENTIONED

Sample No. 24, Elco gravel pit of Internationl Silica Company, E. ½ sec. 7, T. 14 S., R. 1 W. Sample of white, cherty clay from the west face of the east pit.

Sample 39 is taken from an outcrop of 3 feet of gray clay exposed in Miami Hollow, about half a mile east of the south end of the powder plant at Fayville, in the E. ½ sec. 27, T. 15 S., R. 3 W. It would be practically impossible to obtain any quantity of this clay except by underground mining, inasmuch as the overburden is very heavy and this is the lowest formation exposed in the valley.

Sample 38 is taken from a 4-foot bed of drab-gray clay lying 7 feet above sample 39 at the same location. Between it and the bed from which sample 39 was taken are 6 feet of clayey sand underlain by one foot of ferruginous conglomerate. The overburden on Sample 38 is heavy and underground mining would be necessary to obtain the clay in any quantity.

Sample 92 was obtained from the southernmost clay pit of a series of pits located about half a mile south of Round Knob near the center of sec. 2, T. 15 S., R. 4 E. The section in this vicinity is as follows:

	Thickness *Feet*
Loess	3 to 20
Conglomerate, brown chert	½ to 2
Sand, red, locally cemented to sandstone	2 to 7
Clay, buff (Sample 92)	20+